PROJECT CALL 8.0

GUIDEBOOK

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PREFACE

Project Call (PC) 8.0 is the eighth project call issued by NextFlex® (the "Institute"). Like the preceding project calls, it is intended to advance the state of the art in manufacturing for Flexible Hybrid Electronics (FHE) and to promote the strength, competitiveness, and interconnectedness of the U.S. manufacturing ecosystem for FHE. Each NextFlex project call has a unique character and implements changes relative to past project calls, and all proposers should carefully read all sections of this guidebook to understand changes in proposal development, required content, submission, evaluation, eligibility, and selection criteria. Important considerations for PC 8.0:

- Proposal process will be 1-stage (straight to full proposal) – there is no pre-proposal round
- Discussion with NextFlex during proposal development is strongly encouraged to ensure that proposals align to the goals of the topics
- Projects are expected to be technically focused and of modest duration (maximum duration from 12 to 18 months, by topic)
- Topic areas are broadly defined, allowing proposers to determine the specific subject of their proposal; proposals should explain the importance and relevance of the chosen subject
- Alignment of proposals to DoD Critical Technology Areas is strongly encouraged (for more information, see https://www.cto.mil/usdre-strat-vision-critical-tech-areas/)

SECTION 1. FHE DEFINITION

NextFlex uses a broad definition of FHE when advancing the ecosystem. The Institute definition includes electronics that incorporate additively manufactured circuitry, passive devices, and sensor systems that may be manufactured using printing methods (sometimes referred to as printed electronics) along with discrete components (e.g. thin flexible silicon chips or multichip interposer structures, passive devices, sensors, etc.). These devices take advantage of the power and miniaturization of silicon and the economies and unique capabilities of printed circuitry to form a new class of devices for the Internet of Things (IoT), medical, robotics, consumer, communication, and defense markets. FHE devices may conform to any shape, and may also bend, twist, and stretch. While NextFlex primarily uses the term "flexible," the Institute is broadly focused on hybrid electronics manufacturing methods, which includes rigid, flexible, stretchable, conformable, conformal (circuitry applied directly to a 3D surface without the need for a substrate or carrier, also called direct-deposited circuitry); mechanical flexibility is a possible attribute, though not a requirement for hybrid electronics and projects may or may not focus on devices that are mechanically flexible. Closely related hybrid electronics topics that employ these manufacturing approaches, such as additive semiconductor packaging and additive printed circuit fabrication, are in-scope.

In light of this, the Institute will focus its efforts on solutions that incorporate discrete components into flexible, stretchable, conformal, or rigid systems with a significant component of additive processing as part of the design and fabrication approach. Proposals and approaches that target pure "printed systems" or additive processing of organic transistors or other logic systems (metal oxide, carbon nanotubes) as their primary focus will most likely be considered at too low of a Technology Readiness Level (TRL) for Institute Project Calls at this time. Conversely, approaches that appear to be incremental advancements on currently mature manufacturing technologies will potentially be considered at too high a TRL/MRL (Manufacturing Readiness Level) to be considered for Institute funding (such as a traditional printed flexible circuit board approach utilizing solely etched copper for conductors, Commercial Off the Shelf (COTS) packaged die for the active components at the system level, and solder reflow assembly). More details on MRL and TRL can be found at http://www.nextflex.us/trl-cheat-sheet/ and http://www.dodmrl.com/.

SECTION 2. INTRODUCTION AND BACKGROUND

As a Manufacturing Innovation Institute that is part of Manufacturing USA, NextFlex is an industry-led, dynamic, collaboration-based Institute formed to facilitate technology innovation, transition, and commercialization, accelerate workforce development, and promote sustainable U.S. ecosystems for advanced manufacturing. One mechanism to enable technology adoption is to provide funding to proposal

teams undertaking development projects that are critical to FHE manufacturing. In these cases, the Institute may provide funding for up to 50 percent of the development cost of the project through a structured selection process. Projects submitted to NextFlex for funding should consider the value to the Institute and the FHE industry as well as the future goals of advancing the FHE ecosystem within the U.S., and clearly articulate those aspects to the Institute in the proposal process. In addition, all projects should define a commercialization or technology transition plan that demonstrates industry pull for the proposed manufacturing technology development.

It is an underlying tenet of the Institute funding model that projects should benefit all members, not only those performing the work. Projects are typically proposed and executed as a collaboration between at least several member organizations (e.g. companies and/or universities). Each project team presents periodic updates and publishes technical reports for other NextFlex members to review.

Project Call 8.0 addresses prioritized technical gaps identified in the FHE Technology Roadmap developed by the NextFlex Technical Working Groups (TWGs) through partnership among industry, government, and university subject matter experts (SMEs). PC 8.0 emphasizes projects that address critical hybrid electronics manufacturing challenges, enabling the transition of FHE devices into applications that require superior performance, assured reliability, and improved environmental sustainability.

Projects are intended to be technically focused, of moderate size, and of duration consistent with recent past NextFlex Project Calls. Project topics are associated with both the Manufacturing Thrust Area (MTA) and Technology Platform Demonstrator (TPD) TWGs; each topic aligns with the roadmap gaps from one or more working group. Projects that aim to develop FHE demonstrators should also address manufacturing challenges associated with applications and devices in those areas.

Through the first seven Project Calls, NextFlex has increasingly focused the process, building upon developments from preceding Project Calls. A summary of the technical focus of each previous NextFlex Project Calls is presented in Table 1.

Table 1: Summary of the technical focus of previous Project Calls.

Project Call	Technical Focus
PC 1.0	Human health monitoring and asset monitoring
PC 2.0	Equipment development for FHE-specific production tools, process development, and demonstrators
PC 3.0	Subsystem development and manufacturing process or capability gaps
PC 4.0	Areas lacking in MRL and demonstrators showing newly enabled applications
PC 5.0	Manufacturing gaps and growing DoD agency connections
PC 6.0	Broad topics addressing manufacturing and technology gaps from FHE Technology Roadmap
PC 7.0	Prioritized manufacturing gaps and additive semiconductor packaging and PCBs

Project Call 8.0 continues the use of broadly defined topics to enable a diverse proposer base, with special emphasis on areas in which FHE can impact high priority U.S. manufacturing opportunities and areas of emerging importance within the FHE community. Proposals should build on and take advantage of developments from prior project calls, where appropriate, as well as the best available technology.

Projects are expected to address industry-driven problems, with proposed solutions and concepts to transition to the U.S. industrial manufacturing base. Within the broadly defined topics, proposers must identify the specific needs and opportunities as well as the impact that success will have on the U.S. FHE manufacturing ecosystem. PC 8.0 is anticipated to fund up to approximately $4.4M, potentially resulting in multiple awards in one or more topics. Including cost-share, the total project value is expected to exceed $9.4M based on recent historical projects. The number of awards per topic will be based on the quantity and quality of the submitted proposals, the funding requests of those proposals, and alignment with the overall roadmap and mission of the Institute.

Projects focused on developing or demonstrating manufacturing capabilities will focus on developing processes, critical components, foundational data, or software tools. Projects proposing to develop FHE demonstrators may produce fully functioning systems or focus on demonstrating FHE-based subsystems. In the latter case it is important that the proposal clearly describe criteria, metrics, and methods for how the demonstrator will be evaluated to show that the project advances the field. Projects that produce demonstrator devices will be required to produce a sufficient quantity of these demonstrators/prototypes to ensure that scalable manufacturing techniques are used in the production thereof. Efforts in all areas will be expected to generate data to be shared with the NextFlex member community through the NextFlex Materials and Process Database or other appropriate means, as well as generate data that can be used for creation of design rules, models, and standards, including for FHE process design kits (PDKs).

In the interest of expanding the set of organizations leading Project Call projects, NextFlex has included an open topic for “new project leads” (defined as organizations that have not led a project in PC 6.0, PC 7.0, or an Open Project Call within the last two years). This topic allows submission of proposals that address any gap on the NextFlex FHE Roadmaps or topics that are not currently captured by the FHE Roadmaps but have justification for inclusion in future roadmap updates to address an unmet need in the ecosystem. Proposers should pay special attention to proposal, teaming, and eligibility requirements and seek clarification from NextFlex if necessary. Proposers and teams that meet the eligibility requirement may submit proposals to the “new project leads” open topic even if the topic’s scope falls within that of other PC 8.0 topics. Differences in funding limits should be noted when deciding to which topic to submit a proposal.

Important considerations:

- NextFlex anticipates funding one or more project in each topic area; however, other outcomes are possible depending on the cost and quality of the projects proposed.
- Given the clear focus on projects that have a near-term commercial impact and transition potential, teams that are industry-led or have a strong industry partner as part of the commercialization plan will be favorably considered in the evaluation process.
- Proposals that fall within the topics area definitions that address DoD Critical Technology Areas will be viewed favorably.
- Prior to final granting of awards, recipients and their partners who are not already NextFlex members will be required to become members of the Institute and execute a development agreement.
- Should teams find that the topics listed herein are not of interest to their organizations, NextFlex always welcomes suggestions for future project call topics; recommendations should be brought to the attention of the NextFlex TWGs.

NextFlex Technology Hub and Pilot Line: NextFlex and its members have collaborated to create a shared FHE fabrication facility for prototyping and low volume manufacturing in a class 10,000 cleanroom, along with the design and process engineering to support it. This facility, the NextFlex “Technology Hub,” includes both standard EMS and printing tools as well as FHE manufacturing tools developed through prior Project Calls. Capabilities are intended to provide a transition from development to production manufacturing for Institute members. The NextFlex Technology Hub is an ideal environment to integrate and collaborate across projects, thereby strengthening long-term capabilities for the FHE community. Proposal teams are encouraged, when possible, to:

1) Leverage the FHE manufacturing and testing capabilities in the NextFlex Technology Hub during the execution of the project, and
2) Demonstrate newly developed FHE manufacturing processes on the Technology Hub tools. This facility may also be appropriate for technology demonstrator projects.

To accomplish these, proposal teams may seek the involvement of NextFlex Technology Hub staff from engineering and fab groups in projects.

Proposal teams may receive more information about the Technology Hub and its capabilities through the website * and may initiate discussion about integrating its capabilities into proposals by contacting proposal@nextflex.us.

Manufacturing USA – A New Way of Doing Things: All submitters, regardless of prior proposal experience, should take special note that the ways in which NextFlex and Manufacturing USA Institutes operate may be quite different than those to which proposers may be accustomed. NextFlex development projects should not be compared to SBIR, STTR, NIH, or other similar programs. The objective is not to develop a specific product nor to conduct basic scientific research, but rather to solve common gaps that many companies in the FHE manufacturing ecosystem are facing. Research institutions familiar with NIH or NSF funding should be aware that NextFlex projects are intended to be Advanced Technology Development and designed around time-bound and measurable deliverables with clear performance metrics. If these cannot be established at the outset of the project, the subject matter under consideration may be of too low an MRL and thus more suitable for submission to an agency focused on basic research. For those accustomed to government acquisitions, these programs are aimed at co-funded development; thus, a cost share element is required. Companies that typically focus on commercial customer activities should be aware that because these projects are not aimed at developing or delivering a specific product, the *approach taken* is as important as the promised outcomes, and the proposal evaluation criteria reflect this. Project funding will follow a cost reimbursable agreement. If the lead or any partners of the proposal team have audited indirect rates, please use those. Commercial rates or profit (fee) are not allowable for Project Call proposal submissions.

Project Scale and Duration: The federal funding available on a per project, per topic basis is indicated in each topic description section. These numbers were developed by the Technical Working Group process, based on anticipated scope and resources required to deliver the requested statement of work. The maximum duration of proposed projects ranges by topic from 12 to 18 months or less for PC 8.0 and the maximum for each topic is specified; aggressive timelines are encouraged.

NextFlex projects must meet a minimum MRL of 4 in the foundational work upon which projects are built. In consideration of this requirement, proposing teams must demonstrate that this criterion is met by providing sufficient evidence in the technical proposal (e.g. by providing published references, photos and data regarding physical demonstrators, etc.) or in an accompanying file submission (to be used for information that cannot be presented in the written proposal, e.g. video demonstration). Such accompanying submissions must not be used to exceed the proposal length limits. The option to provide physical samples to demonstrate MRL may be discussed during pre-submission consultation with NextFlex.

Cross-Institute Collaboration and Leveraged Funding: As of 2023, 16 Manufacturing USA Institutes exist in various technology areas. Proposals that enable collaboration between Institute programs and have access to funding from more than one Institute should be identified by the proposers for the consideration of the reviewer base, as collaboration across technology fields with strong market demand is always encouraged. NextFlex also encourages proposals that bring in co-investment from other sources including other government agencies, commercial sponsors, state governments and where appropriate, other type of research entities. Projects with co-investment by DoD customers and those that complement other ongoing DoD sponsored projects are highly encouraged and such leverage should be described to the extent possible.

* https://www.nextflex.us/nextflex-for-industry/, https://www.nextflex.us/commercial-services/tech-hub-services/, https://www.nextflex.us/commercial-services/tech-hub-equipment/

Leverage of Other Programs: As already noted, projects that address DoD Critical Technology Areas are strongly encouraged. Proposers that are currently working on programs funded by other sources that could be enhanced by additional scope funded through this project call may propose such activities. All requirements of this project call must still be met. Such leverage of other sources of funding sources will be viewed favorably, however it should be noted that other government funding cannot be counted as cost share and no cost share may be double-counted for separate projects.

SECTION 3. FHE ROADMAP – 2022 UPDATE

NextFlex and the field of FHE leverage a broad U.S. industrial base including the electronics industry and the high-performance printing industry, both well-established U.S. industrial and academic areas of strength. NextFlex members have developed a comprehensive roadmap by collaboration among industrial partners, academics, and government SMEs in a variety of fields. The roadmap topics include different facets of application-specific devices/components for technology demonstration as well as various aspects covering design, materials, process, equipment, and test development that would enable realizing advanced manufacturing capabilities to meet the overall vision of the Institute and the FHE ecosystem. The following areas are the focus of the Technical Working Groups that developed the roadmap:

- Manufacturing Thrust Area
  - Device Integration & Packaging
  - Materials
  - Modeling & Design
  - Printed Flexible Components & Microfluidics
  - Standards, Test & Reliability

- Technology Platform Demonstrators
  - Asset Monitoring Systems
  - Automotive
  - Flexible Power
  - Human Monitoring Systems
  - Integrated Array Antennas
  - Soft & Wearable Robotics

Successful proposals must align to the NextFlex FHE Roadmap, and all proposals should identify the Technical Working Group and roadmap elements to which they align. Access to the NextFlex FHE Roadmaps is a benefit of NextFlex membership. Beginning in 2022, NextFlex has produced a public summary of the FHE Roadmap that is available to non-members and may be useful in formulating proposals. Non-member proposers are encouraged to consult with NextFlex as outlined later in this document or to partner with NextFlex members on proposals to ensure alignment.

Since technology transition and adoption through enabling manufacturing readiness is the primary mission of the Institute, only proposals in the TRL 4 to 7 and MRL 4 to 7 range will be considered for funding. Based on the gaps identified through the TWG road-mapping process, proposals in the following areas have been prioritized and will be considered for potential funding in PC 8.0.

SECTION 4. PROJECT CALL TOPICS

In PC 8.0, there are six Project Call topics, which aim to advance FHE technology and fill gaps identified by the TWGs in the FHE Roadmaps. The outcomes of the projects that are selected are expected to have broad impact on both commercial and defense applications and to advance U.S. FHE manufacturing capability. All proposers are encouraged to build off developments from previous NextFlex project calls.

As the NextFlex community and FHE manufacturing matures, there are opportunities to combine NextFlex development investments with other government agencies or commercial interests. To that end, proposals

that bring external DoD agency funding for technology solutions to specific DoD requirements or direct funding from a separate commercial business unit will be viewed favorably during evaluation. Additional DoD agency funding can be executed through the NextFlex cooperative agreement or a separate agreement or contract.

A natural evolution of the field of FHE is a shift to focus on reliability of FHE solutions and the importance of standards-based testing. All PC 8.0 proposals are encouraged to address these needs for reliability and standards within their project plans in a manner appropriate for the topic and specific proposal.

Table 2 presents a summary of Project Call 8.0 topics and the TWGs with which they align, either directly or indirectly.

Table 2: Project Call 8.0 topic summary

Topic #	Topic Description	Max Duration (months)	Max Funding *	Technical Working Group Alignment										
				Printed Components & Microfluidics	Materials	Device Integration & Packaging	Modeling & Design	Standard, Test & Reliability	Human Monitoring Systems	Asset Monitoring Systems	Integrated Array Antennas	Soft & Wearable Robotics	Flexible Power	Automotive
8.1	Additively Manufactured 3D Devices with Increased Complexity	18	$ 500k	X		X	O	O		O	X			X
8.2	High Performance FHE Interconnects	18	$ 500k	X		X			O		O	X		O
8.3	Harsh Environment Hybrid Electronic Components with Proven Reliability	18	$ 500k	O	O	X		X	O	X	O		X	X
8.4	Advancing the Manufacturability of FHE Processes Towards Standardization	18	$ 500k	X		X	X	O			O			
8.5	Environmentally Sustainable FHE Manufacturing, Design Strategies, and Use-Cases	18	$ 500k		X	O		O		O				
8.6	Open Topic for "New Project Leads"	12	$ 400k	X	X	X	X	X	X	X	X	X	X	X
				X	Direct TWG Alignment									
				O	Indirect TWG Alignment									

The objectives of these projects are to focus on developing and qualifying manufacturing processes, methods, or tools, or demonstrating FHE systems and subsystems identified as gaps via the roadmapping process and discussions with TWG leads, members, and government partners. The processes and the tools developed will have a considerable impact on the manufacture of cost-effective, reliable systems for a wide range of defense and commercial applications. Technology transition to the manufacturing base is an objective for programs, including transfer of process knowledge or developed processes. As such, having demonstrated participation and support from a manufacturing organization and / or government transition partner strengthens a proposal. For example, a process development proposal from an R&D organization may include an original equipment manufacturer (OEM) or contract manufacturer as a team member, and a letter of support indicating that organization's interest in implementing the process. Similarly, a proposal that develops a capability of interest to a DoD stakeholders may include a letter describing the stakeholder's specific interests in the project. Although government partners cannot be funded team members on a project, they can participate in the performance of the project if separately funded. Transition partnerships may take many forms and the preceding examples of industry and DoD partnerships are meant for illustration only.

*Max Funding reflects the maximum funding from NextFlex for an individual project on each topic. Total program value must include the required minimum 1:1 cost share.

Any development of software tools should include licenses or provisions to allow NextFlex members and Institute personnel to access and use the tools for development purposes, and it is expected that third-party licensing needs or maintenance costs required to operate the tools will be considered by the proposal team and addressed as part of the proposal.

In the case of projects focused on process development, it is expected that those developments will be documented with enough detail that they are reliably replicable and that they may be included in manufacturing guidelines for relevant processes in the future. Processes or approaches developed under NextFlex Project Call funding must provide unencumbered use licenses for their implementation at the NextFlex Technology Hub to continue the advancement of the NextFlex FHE ecosystem.

More specifically, these topics shall include, but are not limited to, the following deliverables:

1. Material & Process Database inputs at quarterly reporting intervals following the acquisition of the data.
2. A flow chart of the process steps and design information (such as drawings, CAD files, etc.) for device fabrication or process repetition.
3. Relevant process information including:
    a. Resolution, thickness, and material properties (e.g., sheet resistance) that can be obtained with the developed recipe
    b. Tolerance and yield of components, along with a comparison to device manufacturing processes that are currently used in the industry
    c. Consistency of print quality (line edge roughness, loss or gain in dimension, uniformity in thickness and layer roughness) of the layer(s) in the device
    d. Consistency in device properties (resistance, capacitance, inductance, etc.) along with a comparison to similar devices that are commercially available
    e. Optimized print equipment parameters (print speed, ink volumes, ink viscosity, curing conditions, print environment, etc.)
    f. Mechanical constraints (e.g., tensile strength, bending) of the printed devices
4. Details of the method of test and measurement performed during development to establish TRL and MRL advancements.
5. Identification of the specific task and outcome that results in TRL and/or MRL advancements.
6. Cost model framework and associated assumptions for the proposed manufacturing technique.

Proposals that focus on the development of technology demonstrators should describe the relevance of the application in sufficient detail that reviewers who are subject matter experts in FHE and other application areas can assess and compare proposals that address varying application areas. Generally, technology demonstrator projects may address quite disparate applications within a particular topic area, and as such the business case and relevance of the application is a technical merit factor. Technology demonstrator proposals shall also describe specifically the technical need and commercial value of FHE to this application area within the proposal's innovative claims and commercial strategy sections.

The following section outlines the topic areas for PC 8.0. Each topic has a maximum funding and duration; proposals that seek lower levels of funding and shorter duration are welcome. Most of the topics are structured with a description that include all requirements, followed by examples of proposal subject matter that would meet the topic area requirements and align to prioritized roadmap gaps. These examples are not sub-topics into which proposals must fit, and any proposal that meets the topic area requirements will be equally considered whether it addresses one of the examples or not. Moreover, a proposal may address only part of an example area and still be responsive to the Topic so long as it meets all requirements of the Topic.

Topic 8.1: Additively Manufactured 3D Devices with Increased Complexity

$500,000 maximum Institute funds / Up to an 18-month duration

Hybrid electronic manufacturing has shown potential to complement and potentially supplant traditional device and component processes. To achieve this, complex 3D architectures are required to fully utilize the advantages of additive approaches. This topic seeks development and evaluation of manufacturing approaches for multilayer electrical devices that can be transitioned to volume-manufacturing scale. Proposers are encouraged to produce enough test articles to estimate yield and include modeling and simulation of RF performance, if appropriate. Proposers must identify why the manufacturing approach is preferred over the state-of-the-art. Examples of possible approaches of interest include, but are not limited to:

a. Manufacturing of Multilayer, Multifunctional FHE Devices
This area seeks demonstration of multifunctional prototype devices in a 3D printed geometric structure that require at least four conductive layers and more than 20 passive electronic components in a single printed structure. Demonstrated attachment of multiple 40+ pin electronic components with high yield is sought. Architectures should be optimized for product function and reliability. Innovative 3D design is required for a successful award. Devices should include a combination of a power source, on/off switch, LED indicators, sensor functionality, and wireless transmission. Capabilities and requirements must be clearly defined by proposers and must align with the proposed application use-case.

b. Devices with Embedded Printed Passives
This area seeks demonstration of printed passive electrical components, including resistors, capacitors, and/or inductors, embedded within a fully printed multilayer device. Proposers must show repeatability and reliability of embedded passive components using testing protocols appropriate for a given application(s). Development of manufacturing design rules for yield, reliability, and performance is highly desired and should align closely with current standards used by contract manufacturers of PCBs, electrical components, and devices. The goal of this effort should be to reduce the volume of embedded passive components below that of the package size of COTS components, such as 0201s and 01005s, while maintaining comparable performance.

c. Miniaturization of 3D Printed Antennas
This area seeks demonstration and evaluation of compact 3D printed antennas that operate over a single use channel between 0.9 and 2.6 GHz with the goal of providing complex form factors that enable FHE / additive processes to compete with ultra-compact 3D COTS antenna components for BLE, GPS, and 900 MHz communications. Proposers must define how their efforts will improve upon existing COTS capabilities and SWaP-C requirements. (For example, state-of-the-art COTS ceramic BLE antennas are 3 x 3 x 5 mm).

d. Conformal FHE-based mmWave Radar Sensors
Seamless integration of electrical components into automotive interiors and exteriors is generally considered a requirement for next-generation vehicles. FHE-based electronics will play an important role to meet this need and needs to be demonstrated. Currently, most of FHE-based electronic systems are operating in low-frequency (e.g. MHz). The implementation of fully-printed FHE-based radar sensors operating at millimeter-wave (mmWave) frequencies have not yet been demonstrated. This area seeks demonstration of printed mmWave radar sensors that have the potential to be seamlessly integrated into non-planar, complex surfaces, such as vehicle door panels or bumpers. The focus of this effort is expected to be on development of the front-end antenna, not a completely integrated functional system.

Topic 8.2: High Performance FHE Interconnects

$500,000 maximum Institute funds / Up to an 18-month duration

Recent advances in FHE technologies have pushed the state-of-the-art for manufacturing robust electromechanical interconnects in devices with conventional requirements. This topic seeks to continue to push development of interconnect manufacturing into focus areas of particular interest including, high temperature packaging, high performance co-packaged optics, and highly stretchable electronics. Examples of possible topics include:

a. Additive Packaging for Sustained High Temperature Operation
Complex and wide band gap semiconductors show great promise for high power electronics but introduce numerous materials and thermal challenges associated with many traditional FHE approaches. This topic seeks solutions for hybrid electronic interconnects for high power electronics including packaging of high-voltage modules, high-current modules, and wide bandgap semiconductors (SiC, GaN, etc.) designed for sustained functionality at temperatures greater than 250°C. Use of high temperature substrates (such as ceramics) and passive or active component cooling schemes via microfluidics or similar heat exchangers are of interest. Proposers should clearly define power and temperature requirements based on the intended use-case(s).

b. FHE Manufacturing of Electro-Optical Circuits
This topic seeks materials and process identification and advancement in the manufacturing readiness of assembly and packaging processes for electro-optical flexible circuits. Flexible electrical / optical (E-O) interface assemblies should be capable of typical bend radii while protecting critical optical interconnects. Environmental testing of these interconnects is of particular importance. Proposals should address the following manufacture, assembly, and packaging process steps, as well as documentation:

i. Manufacture of flexible substrate containing both electrical and optical embedded circuits
ii. Methods of assembly and optical alignment of E-O components (typically bare die) to flexible substrate
iii. Electrical connectivity from RFICs to interposer (wirebond, flip-chip, printed interconnect)
iv. Reliability testing of package in target environments

Proposers shall include targeted test systems and expected benefits. This project will expand the capabilities of FHE technology to include integrated optics, enabling higher bandwidths at power, while improving on optical integration processes across all substrates.

c. FHE Interfaces for Rigid, Flex, and Stretch Components
Significant electromechanical challenges exist when interfacing components with highly disparate mechanical properties, such as connectors for textile-integrated sensors, stretchable electrodes in human monitoring systems, and RF connectors for integrated array antennas on aircraft and automotive platforms. Techniques like substrate moduli gradienting and *ad hoc* strain isolation designs have been utilized to overcome these mechanics challenges, but these methods have not been demonstrated at manufacture scale. This area seeks evaluation of available manufacturing processes for reliably connecting FHE components with rigid, flexible and stretchable system elements.

Topic 8.3: Harsh Environment FHE Components with Proven Reliability

$500,000 maximum Institute funds / Up to an 18-month duration

This topic seeks evaluation of FHE components designed for harsh environment applications that include high or low temperatures, extreme thermal cycling, high power, high vibration, G-force / shock, vacuum, and / or radiation. Projects should include full reliability testing appropriate for the target use-

case. Alignment to specific standards (i.e. MIL-STD-810G, or similar) is required. Examples of projects of interest include, but are not limited to:

a. Evaluation of Hybrid Electronics for Space Applications

Many programs in FHE have a need to function in space-like environments or were designed with the intention of being used in space. There is a need for additional testing data showing that these substrates can function in space or space-like environments. Subsequently, FHE designs need to be tested and evaluated against the associated space orbit requirements, including radiation requirements for low earth, medium earth, geosynchronous, and geostationary orbits. Common space-effects testing may include: Functional and Static Thermal cycling, Vacuum/Depressurization testing, Thermal Vacuum testing, Shock and Vibration, Radiation testing including proton, x-ray, heavy ion, and pulsed photon. In this topic, proposers shall identify FHE designs ready for space effects testing (targeting available existing FHE designs rather than designing new systems), perform target testing, provide results and feedback for improvements to design including material suggestions.

Proposals should include:

i. Target FHE designs for test; expected high quantity of consistent builds
ii. List of tests expected to be performed; locations, partners, testing capabilities
iii. Description of features available for active/static testing conditions
iv. Metrics used for tracking acceptable/failure rates throughout process

Projects are expected to leverage prior NextFlex manufacturing and design work. Proposals should be focused on testing and validating existing designs and not designing or re-designing systems for space environments.

b. Reliability of FHE Devices for Harsh Automotive Applications

Modern automotive platforms are increasingly reliant on function-critical and safety-critical electronics sensors and systems. These electronic systems experience temperatures, environmental conditions, and vibration levels that are much harsher than those experienced in typical consumer applications, while long term reliability requirements by automotive OEMs and tier suppliers are among the most rigorous. Furthermore, automotive OEM designers and engineers seek seamless integration of electronic components and systems into interior and exterior body panels, requiring complex, custom package architectures. Hybrid electronics have shown potential to be a solution to this complex requirement set, but additional work is needed to fully characterize and demonstrate the long-term reliability of FHEs designed for this harsh environment. This area seeks evaluation and extensive reliability testing of FHE components and devices intended for automotive applications. Alignment of testing protocols with existing automotive standards is highly desired. Projects involving automotive OEMs and/or tier suppliers are strongly preferred.

c. Printed Coatings with Improved Electromagnetic Interference Shielding

The need for flexible electromagnetic interference (EMI) shields has been a major thrust in addressing radiation effects on printed passives and digital electronics. Composite EMI shielding materials have potential advantages over traditional metal-based EMI shields in terms of processability, flexibility and corrosion resistance for FHE technologies. Moreover, the ability to deposit the ink economically using additive print manufacturing processes on flexible substrates could lead to new applications. While metal-based EMI shields for IC packages and PCB components have been developed, these coatings often suffer from poor chemical resistance, oxidation in long term harsh environments, and cannot be applied to highly dense circuits. This area seeks evaluation of EMI shielding materials capable of being deposited at ambient conditions using additive printing processes on flexible substrates. Proposers must describe the intended use-case(s) for their project and align environmental testing appropriately. Use of existing test standards is highly desired.

Topic 8.4: Advancing the Manufacturability of FHE Processes Towards Standardization

$500,000 maximum Institute funds / Up to an 18-month duration

For hybrid electronics to achieve wide-spread adoption, advancement of manufacturability and standardization of processes is critical. This topic seeks to standardize processing parameters and develop manufacturing design rules for common manufacturing approaches for hybrid electronic components and devices. Successful projects will focus on fully characterizing the manufacturing processes of key components (passives, bare die handling and attach) and devices (circuitization of printed and COTS components, COTs connectors, encapsulation) and formalizing detailed processing parameters and expected performance. All collected processing data should be added to NextFlex's Materials and Process Database and detailed process flows should be disseminated to the NextFlex community. Examples of projects of interest include, but are not limited to:

a. Reliability Testing and Standardization of Fully Additively Manufactured Circuits
This area seeks evaluation and reliability analysis of the hybrid electronics manufactured using a multimaterial printing platform. Both printed substrates and film / substrate-based approaches are within scope. Proposers must perform a comparative analysis of fully additive approaches to traditionally manufactured PCB analogues and the associated IPC or MIL standards, or other industry tests used to assess reliability of a product or manufacturing method. Multiple device designs must be developed and evaluated. Life cycle assessments and cost models comparing manufacturing of fully additively manufacturing electronics versus traditional manufacturing are highly desired.

b. High Volume Manufacturing of Multilayer Passive Components
This area of example seeks evaluation of Roll-to-Roll (R2R) printing equipment with *in situ* processing (including printing and annealing / curing) capable of high print resolution (sub-50 µm) with precision layer-to-layer registration capability (sub-10 µm) for high volume commercial manufacturing of components. Establishment of standard process parameters for printed resistors, capacitors, and inductors for high volume manufacturing are of particular interest using a variety of industry standard FHE substrates and ink systems.

c. Process Parameters and Design Rules Development for Hybrid Electronics
This area seeks to advance the manufacturability of established FHE devices by focusing on one or more significant bottlenecks in current manufacturing flows. Areas of particular interest include, but are not limited to:
    i. IC / component attach yield and reliability
        a. Printed trace, solder attach, low temperature solders, conductive adhesives
    ii. conductive via fabrication
    iii. COTs connector attachment (especially SMA connectors for RF)
    iv. Higher throughput encapsulation / overmolding techniques

    Development of processing parameters and manufacturing design rules including: (a) interactions between ink and substrates (b) line resolution and thickness (c) surface roughness (d) line / spacing, (e) interconnect pitch, etc. are desire. If RF devices are proposed, improved RF/microwave design rules with associated RF performance data are sought. Detailed reliability test methods, including specific combinations of strain amplitude, strain rates, dwells at large or zero strains, different loading modes (tension/compression plus bending), thermal and ambient history (including degradation in storage) are of required.

    For NextFlex members in good-standing, NextFlex can provide designs and manufacturing process details for the most recent flexible microcontroller (A21), or proposers may use their own existing device designs.

Topic 8.5: Environmentally Sustainable FHE Manufacturing, Design Strategies, and Use-Cases

$500,000 maximum Institute funds / Up to an 18-month duration

For this topic, NextFlex has received dedicated funding, and based on the number and quality of proposals received, anticipates awarding three projects.

FHE manufacturing technologies present opportunities to adopt materials and processes that are friendlier to the environment and ecologically sustainable. The full product life cycle from design to recycle / disposal all directly and indirectly have an environmental impact that needs to be evaluated so that cleaner, more sustainable materials and methods can deliver a near-term impact. Additionally, the proven benefits of FHE devices, primarily reduced SWaP-C, can enable novel monitoring applications focused on addressing global climate change. This topic seeks to address sustainability in hybrid electronics manufacturing in three key areas: (1) more sustainable FHE manufacturing and repair processes and materials, (2) life cycle assessment of prototype devices, (3) using FHE devices to address global climate change. Examples of potential projects of interest include, but are not limited to:

a. FHE Manufacturing and Repair for Enhanced Environmental Sustainability
This area seeks utilization of digital printing processes and / or materials with lower environmental impact over traditional circuit board manufacturing. Successful proposals will not duplicate previously funded efforts focused on evaluation of low waste solvent conductive inks and low temperature dielectric processing. Areas of particular interest include:
   i. recycling/upcycling materials
   ii. novel low waste / safer solvents
   iii. use of biodegradable substrates and encapsulants (green silicones, biobased feedstocks, biodegradable polyimides or TPUs)
   iv. material waste removal cost considerations
   v. paper-based substrates
   vi. repair using FHE processes for reduced electronic waste (E-waste) generation

b. Life Cycle Assessment of Hybrid Electronic Devices
This area seeks development of device-level prototypes using more sustainable processes and materials, such as those mentioned in Example 8.5a, with a focus on life cycle assessment and comparative analysis of additive processes versus traditional PCB manufacturing. Proposals focused on quantification of reducing copper plating waste streams by utilizing digital printing processes for circuitization on rigid and flexible substrates are of particular interest.

c. Using FHE Devices to Address Global Climate Change
The benefits of FHE devices, including reduced volume, weight and power requirements, enable novel sensing and monitoring applications. This area seeks demonstration of FHE devices that enable more environmentally sustainable applications. Examples include, but are not limited to:
   i. Low-cost IoT labels integrated into sustainable shipping packages for location and condition monitoring of cold-chain transport
   ii. factory sensors to improve manufacturing and energy efficiency
   iii. biodegradable devices for agricultural monitoring of soil / environmental conditions to address global climate change

Topic 8.6: Open Topic for "New Project Leads"

$400,000 maximum Institute funds / Up to a 12-month duration

Delivering the NextFlex mission requires participation from across the U.S. FHE ecosystem. The purpose of this topic is to encourage participation from organizations that have not led a NextFlex PC project in the recent past.

Projects must align to the NextFlex Technical Working Group FHE Roadmaps and may address either manufacturing thrust or technology demonstrator topics. In the case of technology demonstrator development, the project should, at least in part, address the challenge of manufacturing such a demonstrator.

For this open topic, proposals must clearly identify the technical working group(s) to which the project aligns, and the manufacturing capability gaps to be addressed.

Eligibility requirements: The lead proposer organization for this project must not have led a NextFlex project call project under either of the two most recent project calls (PC 6.0 and PC 7.0), or an Open Project Call within the last two years. As with all proposals, teaming is strongly encouraged; organizations that have led projects under PC 6.0 and/or PC 7.0 may be project partners, however at least 60% of the NextFlex funding for projects in this category must be allocated to organizations that meet the eligibility requirement (there is no restriction on allocation of cost share).

For clarity, organizations that have participated as partners/subcontractors on prior project calls do qualify as "new project leads" provided they have not led a PC 6.0 or PC 7.0 project.

SECTION 5. PROPOSAL SUBMISSION PROCESS

All proposers, including experienced NextFlex project teams, should pay attention to this section, as changes have been made to certain proposal elements and the evaluation process and structure over the last several project calls.

5.1 Project Call 8.0 Timeline

Project Call 8.0 will utilize a single step proposal process. Full proposals are to be submitted directly, rather than utilizing a two-step process with a pre-proposal / white paper stage to select and invite full proposals, as some previous NextFlex Project Calls did. For PC 8.0, these "Full Proposals" are simply referred to as "Proposals."

To ensure that proposal teams have an opportunity to receive feedback from NextFlex on their project concepts, teaming, roadmap and DoD priority alignment, and other relevant criteria, proposers are strongly encouraged to contact NextFlex to schedule a conference call with Institute representatives. These pre-submission consultation calls are a valuable opportunity for all proposers. For proposers that are new to a NextFlex Project Call, this step may be particularly helpful in understanding the nuances of proposals and reviews within the Institute framework. To schedule a pre-submission consultation, please contact proposal@nextflex.us.

Submitted proposals undergo a rigorous multi-tier evaluation as the selection process. Key steps and target dates are outlined in the table below.

Project Call Announcement and Posting	03/21/2023
Optional PC 8.0 Proposers Day Webinar	03/28/2023
Teaming Event	03/28/2023
First Date for Optional Pre-submission Consultation	04/03/2023
Proposal Online Cover Sheet Due	05/04/2023
Proposal Submission Deadline	**05/11/2023**
Approximate Technical Council Review	Mid-June
Approximate Governing Council Review	Late-June

5.2 Required Proposal Elements

A complete proposal shall consist of three separate files:

1. Technical Proposal – following the format and content guidelines below in Sections 5.3 and 5.4
2. Summary PowerPoint Slide – for review purposes, this is considered part of the Technical Proposal although it is submitted as a separate file. Additional information and template link are found in Section 5.3.
3. Budget Workbook (Cost Proposal) according to the NextFlex provided template, to be submitted in Microsoft Excel format. Additional information may be found in Section 5.5.

Proposals will be accepted online at https://nextflex.formstack.com/forms/pc8_proposal_submission until **5:00 PM PACIFIC TIME** on **May 11, 2023**.

5.3 Technical Proposal Format Guidelines

To maintain consistency through submission, review, and approval processes, please follow these guidelines:

Submission. The proposer shall submit one (1) word-processed electronic copy of their proposal via online submission form at https://nextflex.formstack.com/forms/pc8_proposal_submission.

Figures, Graphs, Images, and Pictures. Figures and tables must be numbered and referenced in the text by that number. They should be of a size that is easily readable and may be in landscape orientation. They must fit on an 8.5 by 11-inch paper size.

Font. Proposals are to be prepared with easy-to-read font (such as Times New Roman or Arial), 10-point minimum), single-spaced. Smaller font may be used in figures and tables but must be legible.

Page Layout. The proposal document must be in portrait orientation except for figures, tables, graphs, images, and pictures. Pages shall be single-spaced, 8.5 by 11 inches, with at least one-inch margins on all four sides of each page.

Page Limit. The main body is limited to 15 pages for the proposal. The page limit includes all required sections of the proposal except as indicated in Section 5.3. Pages that exceed these guidelines may not be reviewed.

Page Numbering. Number pages sequentially within each major section of the proposal (frontmatter, proposal content, appendices).

Summary PowerPoint Slide. Each team is required to provide a single PowerPoint slide for their proposal which outlines proposed budget, funding, duration, objective, and deliverables, to be used by the Technical Council while reviewing the projects for selection. Graphics or other relevant and impactful material is often helpful in this regard. A template for this slide may be downloaded at: https://www.nextflex.us/project-call/project-call-8-0/. Proposals that are selected for funding will be required to provide a version of this slide for public release as part of the contracting process.

5.4 Technical Proposal Content Guidelines

The proposal table of contents and guidelines are provided in this section. Please follow instructions in Section 5.2 for format and other requirements. Use the standardized cover page format (Appendix A). The table of contents for the proposal is outlined below. If required, additional tables may be included, but may not be used to artificially exceed the proposal page length. Please ensure that all table or figure references include a clear numbering system and are cross-referenced in the proposal text. Please ensure that proposals clearly identify the current capability and the quantitative target specifications that will determine success of the project.

It is imperative that proposals define milestones that are tangible, measurable, and demonstrable. The specifications of each milestone achievement should be clearly defined as well as the starting state of the art for the same characteristics that the project is improving upon. Examples of tangible milestones may include physical samples, written reports containing collected data, or live demonstrations of functionality.

Content: The proposal shall comply with the following content and structure. Importantly, the budget sheets must be filled out completely and consistent with format provided.

Proposal Table of Contents

Frontmatter – Not Included in the Page Count	
Page I	Cover Page (see Appendix A)
Page II	Table of Contents
Page III-IV	Executive Summary: A succinct summary of **no more than two pages** clearly articulating the big picture problem being addressed, proposal objectives, relevance to FHE, approach to address all critical technical and non-technical aspects, expected outcome and overall cost/cost share information.

Pages 1-15: Proposal Content
There is a 15-page maximum for the proposal, excluding appendices and PowerPoint Slide Project Description; the page count in each section is for guidance. Total number of pages is more important than the page count in each section.

Proposal Content – 15-Page Maximum for Sections 1-7; Sections 8-9 are Excluded from Page Count	
Suggested Length	**Section and Contents**
~1.5 Pages	**1. Background and Need** 1.1. Identify the FHE Opportunity and Proposed Solution 1.2. Describe Background, Current State-Of-The-Art, and Alignment to NextFlex TWGs and DoD Critical Technology Areas* 1.3. Addressed Roadmap Gap (or manufacturing gap not previously identified) and Problem Definition
~4 Pages	**2. Technical Objectives, Scope, and Approach** 2.1. Technical Objectives 2.2. Technical Scope and Approach

*The DoD has described technology focus areas critical for ensuring continued advantage over potential adversaries. If applicable, proposals should call out and clearly describe how the project aligns with one or more of these focus areas. (https://www.cto.mil/usdre-strat-vision-critical-tech-areas/)

	2.3. Innovative Claims* 2.4. Performance and Reliability Metrics/Standards 2.5. Key Target Specifications
~5 Pages	**3. Work Plan** 3.1. Project Schedule 3.2. Detailed Description of Milestones, Tasks, and Deliverables 3.3. Project Risk Assessment and Mitigation Plan 3.4. Project Management Approach, Roles, and Relationship of Key Personnel
~2 Pages	**4. Commercialization Strategy** 4.1. TRL/MRL Assessment (current state of the technology, expected level to be achieved, and explanation of how the proposed work will advance the TRL/MRL) 4.2. Market Analysis, Business Case, and Transition Plan for Proposed Technology (including relevance to the FHE ecosystem)† 4.3. Manufacturing Partners and Approach 4.4. Tool Accessibility to NextFlex Members and Broader Ecosystem (this section is required only for proposals that are developing equipment/tools for manufacturing or test and software such as design or modeling tools) 4.5. IP: Existing Portfolio and Future Strategy (related to the proposal topic)
~1 Page	**5. Budget Justification and Cost Share** 5.1. Summary breakdown of costs (labor, materials, travel, etc.) by project team member. Sources of funding including NextFlex funds, participant cost share, 3rd party cost share, and any other sources. This section provides budgetary information for the technical reviewers. Do not include any proprietary rate information in this section; appendix includes detailed costing. 5.2. Value and Quality of Cost Share
~1.5 Pages	**6. Capability to Meet Technical and Business Goals** 6.1. Key Personnel Experience and Qualifications 6.2. Prior Work Toward This Specific Effort 6.3. Relevant Facilities and Equipment Infrastructure (pertinent to the proposal)
Brief Statement	**7. Workforce Development** 7.1. Education and Training Component of the Proposal. Proposals that include substantial education or workforce development activities (e.g. beyond inclusion of graduate or undergraduate student researchers/developers to carry out technical tasks) should expand this section.
As Needed; Excluded from Page Count	**8. Appendix** 8.1. Bio-sketches 8.2. Facilities and Infrastructure Detail Relevant to the Proposal 8.3. Technical References and List of Patents 8.4. Letters of Support
Excluded from Page Count	**9. Single Page PPT Slide Project Description (format provided)‡**

Please note that this is not a typical government grant or contract opportunity. NextFlex staff are available and encourage clarifying questions and will provide guidance during the process of the proposal preparation.

* For demonstrators, clearly define the value to the ecosystem, long-felt need, and justification for why FHE technology is appropriate/advantageous.

† For demonstrators, describe the commercial need / value of the FHE solution for this application.

5.4 Cost Proposal Guidelines

Proposal cost calculations shall be in the Excel format provided; the spreadsheet should be submitted as a separate file with the submission, not included in the Technical Proposal. For clarity, the technical proposal Section 5.1 includes a high-level budget summary that technical reviewers will use to evaluate the proposal; the cost proposal is used for detailed evaluation by NextFlex staff and government advisors. Cost proposals are not shared with the Technical Reviewers.

The cost proposal spreadsheet may be downloaded at https://www.nextflex.us/project-call/project-call-8-0/
Additional worksheets should be added to the Workbook for additional partner organizations.
Cost proposals must include labor (by staff position / role, not by individual name), materials, travel, and all other direct expenses, and overhead, including overhead rates, each divided by source of funds. Questions about cost proposals including submission of rate information should be addressed to NextFlex at proposal@nextflex.us.

SECTION 6. ADMINISTRATIVE TOPICS

6.1 Confidential Information

It is recognized that it may be desirable to include information that is considered confidential and proprietary by the submitter to fully and effectively convey the technical merits of the proposal. All submitted proposals are distributed for the purpose of review to a slate of reviewers. Besides NextFlex staff, the majority of NextFlex's proposal reviewers are NextFlex members, and as such, they are bound to customary confidentiality provisions (no less than reasonable care standard, marking requirement or written confirmation for oral disclosure, standard exclusions such as for publicly available information) via NextFlex's IP Policy to maintain the confidentiality within the NextFlex membership (relevant IP Policy sections will be made available upon request). Representatives of the U.S. Government also serve as proposal reviewers. NextFlex reserves the right to engage other persons or entities as part of the proposal review process (e.g., third-party SMEs), in which case NextFlex will require such reviewer to enter into a special purpose non-disclosure agreement. Please keep the foregoing in mind when determining the information to provide in your proposal. It is recommended that the included confidential or proprietary information be clearly marked and be limited to the minimum necessary to convey the highlights of the technical approach.

Additionally, proposers must refrain from including Export Controlled information in their submissions. If a proposer believes that inclusion of Export Controlled information is required to fully respond to the technical topic or to fully convey the merits of their proposal, they should contact NextFlex by email to proposal@nextflex.us to discuss this fact no later than the online cover sheet submission deadline; alternative submission and review procedures may be required.

6.2 Financial and Cost Share Requirements

Development agreements will be awarded as cost reimbursement, not-to-exceed contracts, with periodic payments to be made linked to achievement of milestones as presented in the proposal. If the proposer's organization has a US government-approved rate structure, please use it. The methods used to value "cost sharing" must be the same as those used to value the full project costs. All developers are expected to have a government approved or industry standard accounting system by which actual project costs are tracked and reported. This is an absolute requirement to be sure that cost share obligations are met. Overall guidance on the working principles and requirements of cost-share (in-kind cost share, and cash and cash equivalent cost share), including various regulations governing federally funded programs are given in a separate document, "Cost Share Definitions and Guidance," available at https://www.nextflex.us/project-call/project-call-8-0/.

6.3 Work Requirements

To submit a response to PC 8.0 and to subsequently be considered for an award, the following requirements must be met:

- Proposal teams should include at least one corporate/industrial organization and are encouraged to be industrially led when appropriate.
- The company or composite team of companies/government labs/academics must have a significant presence in the US in the form of R&D activities and/or manufacturing. One hundred percent of the work activity (funds) must be spent within the United States operations.
- The company or companies must be committed to making available the developed products and providing to NextFlex and its Members on a right-of-first acceptance basis. Applied research conducted by universities will be considered and does not need to meet this requirement. However, in the latter case, a pathway to commercialization must be envisioned and described.
- Process development projects should include sufficient documentation that the method is replicable at the NextFlex Technology Hub in San Jose, CA, or member companies' facilities or both as appropriate.
- Test methods, materials data, or design tools should be foundational and available for incorporation into tools for the advancement of FHE manufacturing and not limit collaboration.
- The total project funds must be matched at a minimum of 1:1. Teams may determine how to divide that requirement among their members. The cost share is defined in the Participation Agreement to include matching share of the development cost in cash and in-kind contributions, e.g., labor and materials, of at least 50 percent.

6.4 Membership Requirement

To qualify for funding awards, lead organizations on projects that are selected for an award, as well as the other performers on their project team, who are not already members of the Institute, must join NextFlex at the appropriate membership Tier (not Observer Level or Associate Member) before a development agreement can be finalized with the project lead. Suppliers from whom standard parts, components, or materials are acquired, such as those with a catalog part number or industry standard supply chain (e.g., build-to-print part) are exempted from this requirement; this exemption may include experimental grades of materials, components, or parts that are provided at competitive fair market price for the purchased units, not paying for the full development cost of that experimental item. It is the responsibility of the project lead(s) to communicate this requirement to their respective partners and coordinate their membership process with NextFlex. Potential members can find out more at: https://www.nextflex.us/membership-inquiry-form/.

SECTION 7. PROPOSAL EVALUATION CRITERIA

All proposals are evaluated using a three-step process.

1. Review by Subject Matter Experts
2. Selection Recommendations from the NextFlex Technical Council
3. Selection by the NextFlex Governing Council

Details of these steps are found below.

Proposals are assigned to slates of technical reviewers comprising subject matter experts (SMEs) from among NextFlex industry, government, and academic institution members. In rare cases, NextFlex may engage 3rd party SMEs who are not NextFlex members as part of the review process.

Reviewers independently review the technical proposals and provide feedback to NextFlex according to proposal evaluation criteria described below. Based on the quantitative and descriptive feedback from the reviewers, NextFlex formulates a set of recommendations that are considered by the NextFlex Technical Council, which through voting creates a set of recommendations for selection that is sent to the NextFlex Governing Council. Infrequently, the Technical Council may recommend certain proposals subject to modifications. The NextFlex Governing Council, comprising representatives of certain NextFlex industry,

academic, and government member organizations, has final selection authority and considers the recommendations from the Technical Council in voting its recommendations.

In soliciting proposals, NextFlex plans to provide and administer funding that must be matched (1:1 minimum) with funds in the form of cash and in-kind contributions provided by the recipients to cover the total project cost. It is not a requirement that each team member demonstrates a cost share at a minimum of 1:1. However, the entire project must be cost-shared at least 1:1, and ratios greater than 1:1 are highly encouraged.

In responding to this solicitation, partnering among industrial companies or industrial company/R&D organization/university/government teams is very strongly encouraged. Individual company responses may be appropriate where company size, breadth, and expertise are sufficient to effectively cover all areas (e.g., technical resources, financial stability, and market presence) critical to the successful delivery of the demonstrator, prototypes, processes, or material proposed. Engagement with industry partner(s) will strengthen the value of the submission.

Pre-submission Consultation with NextFlex: All proposers are strongly encouraged to schedule a pre-submission consultation with NextFlex while developing their proposal. The purpose of discussing proposals with NextFlex prior to official submission is to receive feedback on all aspects of the proposal, including technical approach, partnering, connection to previous NextFlex projects, etc. This consultation is meant to strengthen the competitiveness of the proposal. It is the responsibility of each proposing team to decide how to incorporate or not incorporate the feedback. This consultation does not factor into the proposal evaluation.

Proposal Evaluation: Reviewers evaluate proposals against a set of criteria identified in the table below, as well as providing an overall assessment of worthiness of funding and pros and cons. The 13 criteria are divided into Technical (criteria 1 – 7) and Non-Technical (criteria 8 – 13) categories; the criteria scores within each category are averaged to produce a Technical Score and a Non-Technical Score. The combined scores from all reviewers produce both average scores and a Technical Ranking. Project selection relies heavily on the Technical Score and Ranking; Non-Technical Score and reviewer feedback are particularly useful to distinguish proposals that are rated closely to each other, as well as to identify potential outliers (high or low). Ultimate selection relies on the numerical scoring, descriptive reviewer feedback, and the balance of project portfolio.

During the final selection process, communication between the proposers and NextFlex may be initiated over the terms, conditions, specifications, deliverables, schedule, or other relevant factors contained in the proposal in advance of awarding of a contract. (Granting of awards to proposals submitted in response to this Project Call is contingent upon the continued availability of US government funding and subject to mutually agreeable terms and conditions.)

The scores and comments from different reviewers on all proposals will be compiled, ranked, and prioritized; and they will be considered in voting by the Technical Council. The TC may seek additional modifications before making recommendations to the NextFlex Governing Council. Upon approval by the Governing Council, the proposal shall advance to executing Development Agreements prior to awarding any funds and, if the lead developer or its partners are not already a member of NextFlex, also execute a Participation Agreement.

Proposal evaluation criteria are outlined in the table below. The lists of criteria are aligned with sections in the proposal Table of Contents. The explanations for the criteria in Appendix D provide guidelines to the submitters as well as the reviewers regarding relevant information and supporting details to be included in submitted proposals.

Section	Section Title	Criteria
1.0	Background and Need	(1) Problem statement, innovative solution, and potential impact on technical gap and/or DoD priorities
2.0	Technical Objectives	(2) Technical scope and approach
		(3) Logical technical plan; key deliverables and specifications
3.0	Work Plan	(4) Project organization
		(5) Probability of success
4.0	Commercialization Strategy	(6) Business case, value proposition, transition potential
		(7) Manufacturing approach
	Manufacturing Readiness and Accessibility	(8) MRL/TRL assessment
		(9) Tool accessibility (for proposals developing tool hardware and software proposals only)
5.0	Budget Justification and Cost Share	(10) Cost and cost realism
		(11) Value and quality of cost share
6.0	Capability to Meet Technical and Business Goals	(12) Experience of personnel and quality of relevant facilities
7.0	Workforce Development	(13) Quality of WFD section

Proposals that include use of the NextFlex Technology Hub should articulate the value proposition of this partnership to the project. Utilizing the Technology Hub is not an evaluation criterion. Technology Hub utilization in a proposal may be included in context with technical strategy leveraging state-of-the-art FHE capabilities, commercialization strategy, industry-relevant transition of manufacturing processes, and demonstrating manufacturing gaps through a TPD. Any proposal team intending to utilize the Technology Hub in their project should engage NextFlex about this well ahead of proposal submission (as they would any other partner). Proposers needing introductions to the appropriate Technology Hub staff can request introduction by email to proposal@nextflex.us. All projects are encouraged to leverage the NextFlex technical staff expertise.

In support of NextFlex's dual mission to (1) promote development and U.S. manufacturing of FHE and (2) support DoD technology transitions, alignment of projects to DoD Critical Technology Areas will be considered (as described above) in the evaluation of proposals. This alignment may be a factor in the consideration of proposals by the Technical Council and Governing Council. Partnering with DoD labs or other DoD components is allowed and encouraged, however NextFlex funds cannot be paid to DoD.

Workforce Development: Establishing a domestic manufacturing ecosystem in FHE will require not only the development of new manufacturing processes, but also training a workforce to design and manufacture FHE products. To that end, proposals that include a Workforce Development (WFD) component that is well-integrated into the technical work and geared toward training tomorrow's workforce, retraining today's workforce, and/or K-12 STEM outreach activities are favorably considered. WFD may include, but is not limited to, undergraduate and graduate student contributions to projects, FHE internships, FHE course development at community colleges or universities, short course development, the development of STEM programs, etc.

SECTION 8. CONTACT INFORMATION

Communication and questions during the proposal period and submission of proposals should be directed by email to proposal@nextflex.us.

SECTION 9. REFERENCE DOCUMENT KITS

All the following seven (7) reference documents are in the Project Call Reference Documents section of the PC 8.0 webpage (https://www.nextflex.us/project-call/project-call-8-0/):

a. Project Call 8.0 Guidebook
b. Project Call 8.0 FAQ
c. Flexible Hybrid Electronics Technology Roadmap Summaries
d. MRL/TRL Definitions
e. Cost Calculations Template
f. Cost Share Definitions and Guidance
g. Summary PPT Submission Template

Additional membership and submission information is available at the following locations:

h. Membership (https://www.nextflex.us/membership-inquiry-form/)
i. Online Cover Sheet (https://nextflex.formstack.com/forms/pc8_cover_sheet) – Proposal Cover Sheet must be submitted by **May 04, 2023.**
j. Online Submission Form (https://nextflex.formstack.com/forms/pc8_proposal_submission) – Proposal must be submitted by **May 11, 2023**.

SECTION 10. GLOSSARY OF TERMS

Abbreviation	Term
0201	0.02 inch x 0.01 inch Package Size
01005	0.01 inch x 0.005 inch Package Size
3D	Three-Dimensional
AFRL	Air Force Research Lab
BLE	Bluetooth Low Energy
CAD	Computer-Aided Design
COTS	Commercial Off-the-Shelf
DoD	Department of Defense
E-O	Electrical – Optical
EMI	Electromagnetic Interference
FHE	Flexible Hybrid Electronics
GaN	Gallium Nitride
GHz	Gigahertz
GPS	Global Positioning System
GC	Governing Council
IC	Integrated Circuit
I/O	Input / Output
IoT	Internet of Things
LED	Light Emitting Diode
MRL	Manufacturing Readiness Level
MTA	Manufacturing Thrust Area
MHz	Megahertz
µm	Micron
mm	Millimeter
mmWave	Millimeter wave (30 GHz – 300 GHz)
OEM	Original Equipment Manufacturer
PC	Project Call

PDK	Process Design Kit
PI	Principal Investigator (i.e., leader for a project)
PCB	Printed Circuit Board
R&D	Research and Development
RF	Radio Frequency
R2R	Roll-to-Roll
ROM	Rough Order of Magnitude
SiC	Silicon Carbide
SWaP-C	Size, Weight, Power, and Cost
SME	Subject Matter Expert
SMA	SubMiniature version A
STEM	Science, Technology, Engineering, and Mathematics
TC	Technical Council (comprised of SMEs and voting Tier 1 and Tier 2 members from industry and academia)
TPD	Technology Platform Demonstrator
TRL	Technology Readiness Level
TWG	Technical Working Group
TPU	Thermoplastic Polyurethane
WFD	Workforce Development

SECTION 11. APPENDICES

Appendix A: Cover Sheet Template

The chart below is to help you anticipate what information will be requested for your online cover sheet submission. Submission of cover sheets is required by the specified date to allow NextFlex to anticipate proposals that will be received and pre-align reviewers to facilitate timely proposal review. Estimated (ROM) project costs are required with the online cover sheet; it is expected that proposal teams may still be finalizing proposals and budgets at the time of the online cover sheet submission. Updated and final costs must be provided with the proposal submission.

To generate and submit an online cover sheet, please fill out the form:

https://nextflex.formstack.com/forms/pc8_cover_sheet

NextFlex PC 8.0 Cover Sheet Template	
Project Title	
Date of Submission	
Project Leader	
Organization, Department, and Address	
DUNS Number	
Project Leader's Phone Number	
Project Leader's Email Address	
Industry Partner / Subcontractor Organization(s)*	Provide full name, location, and other details
Non-Industry Partner / Subcontractor Organization(s)†	Provide full name, location, and other details
Supplier Organization(s)‡	Provide full name, location, and other details
Project Topic Category	
MRL Level – Start	
MRL Level – Finish	
TRL Level – Start	
TRL Level – Finish	
NextFlex Membership Status and Level	
Estimated Total Project Cost:	$
Estimated Cost Share (in-kind, labor, material, etc.)	$
Estimated Cost Request from NextFlex	$
Project Duration (Months)	

* Industry Partner / Subcontractor Organizations are companies with whom the lead proposer organization is collaborating on the development work. This does not include suppliers of COTS components.
† Non-Industry Partner / Subcontractor Organizations are organizations (e.g. Universities) that are not for-profit companies.
‡ Supplier Organizations are other organizations that will *meaningfully contribute* to the project but that will not carry out funded development work. This may include, for example, key suppliers of COTS parts or services.

Appendix B: Instructions for Filling Out Proposal Cost Calculations Excel Workbook

There are specific requirements for planning and tracking proposal and project spending when receiving federal funding for Institute projects. To support those requirements, please lay out the project financials in the provided format. While budget details will be entered into the Excel tables provided, the following should serve to clarify what needs to be documented and how:

Overall the following areas are important for the Institute to understand:

- Total project cost
- Total cost share, including percent and amount of funding requested from NextFlex
- Type of costs
- In-kind contributions and types thereof
- Hours and rates for labor
- Any equipment purchases planned
- Materials purchases
- Travel expenses

In addition to detail on the above, you must provide spending by calendar year for which the project operates and a breakdown by lead and partners.

Therefore, the following explanation may be helpful.

The spreadsheet includes columns for six budget quarters. Most PC 8.0 topics are limited to shorter durations; do not plan a budget longer than the allowed maximum duration for the topic proposed.

Add additional “Project Detail” and “Cost Detail” tabs for each partner on the project, and please make sure to maintain one “Project Detail Total” and “Cost Detail Total” tab which summarizes the partner breakdown.

The primary objective of this supporting workbook for the project proposal is to ensure that the review process can adequately identify all details of the proposal. Proposals that advance to funded projects will be subject to further documentation and record retention requirements which will be provided in detail to the project lead at that point in time.

If the lead or any partners of the proposal team have audited indirect rates for labor, please use those.

If there are any additional questions on how to prepare the cost calculations workbook, proposers may contact proposal@nextflex.us for further clarification.

Appendix C: Questions for Pre-Submission Consultation with NextFlex

This list of questions has been developed to help proposal teams prepare for their proposal consulation calls with NextFlex. These questions are intended to help make the calls as productive and helpful as possible toward the goal of strengthening proposal competitiveness. The questions take cues from DARPA's Heilmeier Catechism (https://www.darpa.mil/work-with-us/heilmeier-catechism) with additions and modifications relevant to NextFlex project types.

Proposal teams are recommended to answer these questions in writing and provide to NextFlex well ahead of the scheduled call. Written responses must be concise – 2 pages maximum with 10 point font; figures may be included in this page count. During the call, teams will be able to ask questions on these topics or others specific to their proposal concepts.

Proposers should email proposal@nextflex.us to arrange a consultation.

1. Provide a synopsis of the proposed project (short paragraph). What PC 8.0 topic area are you addressing?
2. What is the proposed work attempting to accomplish or do? Avoid jargon.
3. How is it done today / what is the current state of the art, who does it, and what are the limitations?
4. Describe the team composition and team member roles. Why is this the right team to solve the problem? What capability gaps does your team have an what additional capabilities do you need to add (if any)?
5. What is innovative in your approach in the context of existing capabilities? Why do you think you can be successful?
6. What are the key technical challenges in your approach and how do you plan to overcome these? What is your biggest technical risk?
7. Who or what will be affected and what will be the impact if you are successful? Please be as quantitative as possible?
8. What is your proposed budget and duration?
9. What is the pathway to manufacturing or how will this work inprove FHE manufacturing? What additional work will be required after this project is completed to deliver impact on industry, how much will it cost, and how long will it take?
10. What is the one main benefit that your project will deliver to the NextFlex Community and FHE Ecosystem? How will the FHE Ecosystem and the NextFlex community benefit from the project?
11. What are the key non-technical challenges to your project and the barriers to adoption of the proposed approach?
12. Are you requesting support from NextFlex during the execution of your project (material, fab access, engineering services, etc.)?

Appendix D: Proposal Evaluation Criteria

PC8.0 Full Proposal Project Review Criteria / Score Card

Criteria for all Project Call topics — **Score Guide: Low=1, High=5; refer to scoring rubric worksheet**

Reviewer Name: ADD YOUR NAME HERE

Reviewer Organization: ADD YOUR ORGANIZATION HERE

Example Proposer Name

Example Proposal Title

	Proposal Section	Proposal Section	Criteria	Explanation of Criteria	Example Score
Technical Merit & Transition Potential	1.0	Background and Need	(1) Problem statement, innovative solution, and potential impact on technical gap and/or DoD priorities	Evaluate the problem definition in line with the background information and the gap analysis provided. Is the proposal aligned with TWG roadmaps and/or DoD Critical Technology Areas?	3
	2.0	Technical Objectives	(2) Technical scope and approach	Is the objective, scope and approach aligned with the problem definition? Are performance and reliability metrics and standards appropriately addressed? For demonstrator projects, what are the value to the ecosystem and the advantage of an FHE solution for this problem?	5
			(3) Logical technical plan; key deliverables and specifications	Do the specifications and deliverables meet the proposed objectives and final deliverables? What are the key tangible deliverables & how do we assess success?	5
	3.0	Work Plan	(4) Project organization	Is the project organized well with milestones and tasks; Are the task descriptions clearly articulated: Is the schedule aligned well with critical interdependencies identified?	4
			(5) Probability of success	Based on all of the above, including the cost and the team capability, assess the feasibility to achieve the stated goals within the planned timeline.	3
	4.0	Commercialization Strategy	(6) Business case/value proposition	What is the targeted application or market? How is the technology/product a differentiator or a game changer? Is the appropriateness of an FHE solution explained?	5
			(7) Manufacturing approach	Is the technology/approach matured and ready for manufacturing? Is it the right approach? Does it help advance the MRL/TRL goals? Does the team have the right partners? Are they US-based? How the mature is the process and/or manufacturing infrastructure? How does it impact US manufacturing?	4
Non-Technical Factors			(8) MRL/TRL assessment	Are the starting MRL/TRL accurate? Are the end MRL/TRL assessed correctly, and is it realistic considering the overall quality of the project and maturity of technology and approach?	5
			(9) Tool accessibility (for proposals developing tool hardware and software proposals only)	Will the equipment/tool/software developed as part of the proposal be available to the ecosystem, and where they will be located?	3
	5.0	Budget Justification and Cost Share	(10) Cost and cost realism	Evaluate if the cost assessment is pragmatic based on the overall assessment of the project relative to its objective, team, advancement, timeline etc.	4
			(11) Value and quality of cost share	Assess based on the cost share value, cost share source and the purpose of the cost share.	4
	6.0	Capability to Meet Technical and Business Goals	(12) Experience of personnel and quality of relevant facilities	Assess the strength of the PI team as well as the partner/subcontract organizations to achieve the proposal's goals.	4
	7.0	Workforce Development	(13) Quality of WFD section	What aspects of WFD is proposed? Is it intern, graduate student, or training etc.?	2
				Technical Score	**4.14**
				Technical Ranking	**-**
				Non-Technical Score	**3.67**

In addition to numerical scoring, reviewers are asked to respond to the following questions:

- General Comments (Please provide succinct overall comments, especially regarding any particular section under the average score)
- Strengths (Please list the key strengths of the proposal)
- Weaknesses (Please list the key weaknesses of the proposal)
- Does this proposal meet your standard to be fundable?